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Instructions concerning battle maps, annexes

United States. Army war college, Washington, D.C.

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INSTRUCTIONS

CONCERNING

BATTLE MAPS

ANNEXES

TRANSLATED FROM THE FRENCH EDITION
OF FEBRUARY 14, 1916

ARMY WAR COLLEGE
MAY, 1917

WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

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WAR DEPARTMENT,
Document No. 598.
Office of The Adjutant General.

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WAR DEPARTMENT,
WASHINGTON, *May 23, 1917.*

The following instructions concerning Battle Maps (Annexes) are published for the information and guidance of all concerned.

[2605615, A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

TASKER H. BLISS,
Major General, Acting Chief of Staff.

OFFICIAL:

H. P. McCAIN,
The Adjutant General.

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ANNEX I.

NOTES ON SYSTEMS OF PROJECTIONS.

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ANNEX I.

Notes on Systems of Projections.

Sphere—chart—projection.—The earth is sensibly a sphere, its representation on paper is called a map, chart, or plan. Each point of the sphere is represented by a corresponding point on the map. The method used to obtain this representation is called projection.

In the case of a small portion of the sphere for which it may be assumed, without sensible error, that the earth is a plane surface, the map may be a true reduction of the earth's surface; in this case there are no distortions. However, if a very extensive region is shown on the same map, distortions of the earth's surface are necessarily introduced, and then it is necessary to employ projection. Such is the case in the map of a large territory, as of France.

Various methods of projection—geodetic points—rectangular coordinates.—There are a great many kinds of projections; they are derived either with the aid of geometry (perspectives, developments, etc.), or with the aid of algebraic formulae giving the rectangular coordinates X and Y of each point of the map as a function of its geographical coordinates (L=latitude, G=longitude) of the corresponding point of the sphere:

$$X=f(L, G) \qquad Y=\phi(L, G)$$

Special tables prepared by the geographic service of the Army (Plessis tables, Lambert tables of projection) allow the very rapid determination of numerical rectangular coordinates when the latitude and longitude are known.

These tables are always convenient for use in preparing the projections.

In the construction of maps, when by means of geodetic operations the positions of a certain number of important points on the ground have been determined (geodetic points), and their geographical coordinates have been obtained (latitude and longitude), their rectangular coordinates can be calculated by means of the formulae or the above tables.

When the numerical values of the points are thus obtained, they are recorded on a sheet of cross-section paper to a con-

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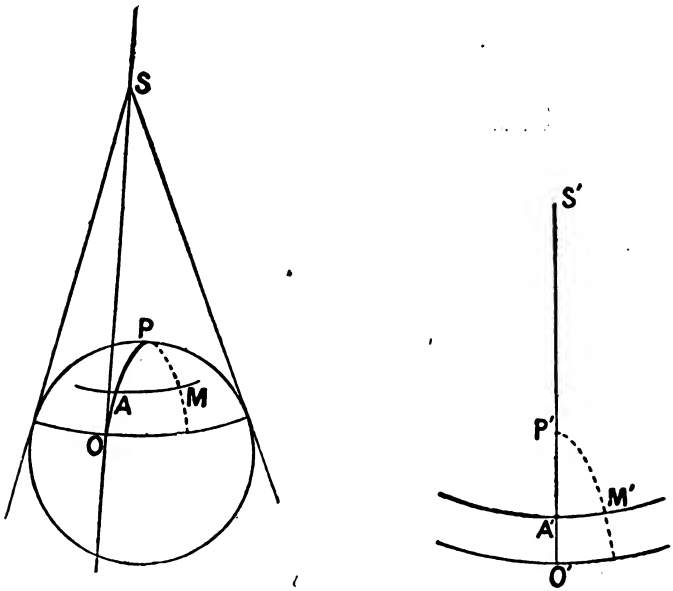
venient scale, and the points thus located give an outline on which may be consolidated the sketches made on the ground.

Bonne's projection, or the official map of France.—In Bonne's projection it is assumed that the earth is developed by means of a cone tangent to the sphere along the mean parallel of the area represented.

A central point O on the mean parallel (L_o=50G, G_o=OG);[1] a longitudinal line S′O′ equal to the element SO of the tangent cone is drawn on the map. The mean parallel is represented by



Sphere. Projection.

a circle whose center is S′ and radius S′O′, along which the lengths are represented in their true value. The other parallels are represented by concentric circles, which are kept at the same intervals as on the sphere (O′A′=OA), and on which distances retain their true values. (A′M′=AM.)

The result of this is that the meridians are represented by curved lines which converge to a point P′ representing the pole P.

[1] This point is found in the Cantal near d'Aurillac. 1G=1 Grade=$\frac{1}{100}$ of circle.

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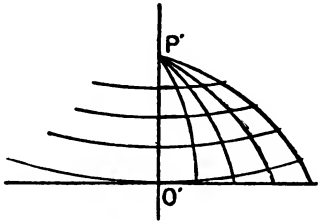
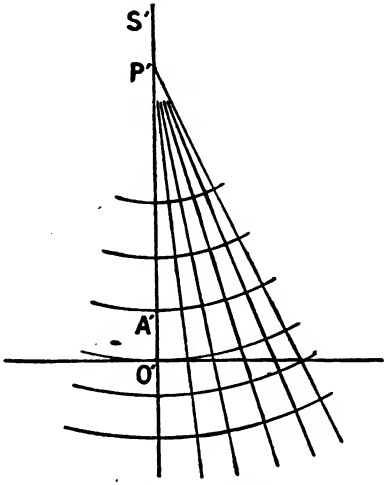
The rectangular coordinates are calculated by taking the point O′ as an origin, O′S′ as the Y axis, and the tangent to the circle at O′ as the X axis.

Lambert projection.—In the Lambert projection the tangent cone is likewise developed; first, however, a supposedly flexible



Bonne projection.

spherical cap is drawn out by the point P until this point is at S, the parallel of the base remaining fixed. This operation is performed in such a way that the distances between successive



Lambert projection.

parallels uniformly increase, starting from the central point O and following the law:

$$O'A'=OA+\frac{OA^3}{6R^2}+\ldots$$

(R=radius of the earth.)

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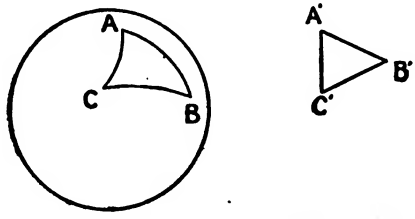
Meridians are represented by right lines intersecting at S′, and the parallels, by concentric circles. This projection has the property of being consistent (see below), and of giving a minimum of distortion for the area considered. The central point chosen for the projection used in battle maps and quadrangled sheets of the western front is the point

$$L_o=55G,\ G_o=6G$$

This point is found near Trèves. Rectangular coordinates are calculated by taking "O" as an origin, O′S′ as the Y axis, and the tangent to the circle at O′ as the X axis.

Distortions in the projections.—As has been said above, it is impossible to represent a considerable portion of the terrestial sphere on the map without introducing distortions, regardless of the method of projection used. For example, at any point of the



Sphere. Projection.

map, let us consider the small figure A′B′C′ which represents the triangle ABC on the sphere; it is practically impossible for these figures to have the same angles and same length of sides (noting in passing that in the case of small figures, about 10 kilometers on the side, the arcs are sensibly right lines).

It is always well to notice that—

1. Since certain projections distort much more than others, when a map of a large territory is to be made, a method of projection is adopted which gives very little distortion to the whole. (Bonne's projection, for the official map of France.)

2. There exists an entire system of projections called "congruous projections," which does not distort the angles (A=A′, B=B′, C=C′).

The Lambert projection is congruous. When the angles are measured on a map made by this system of projection these angles are practically equal to those existing on the ground. The Bonne projection is not congruous; it introduces angular

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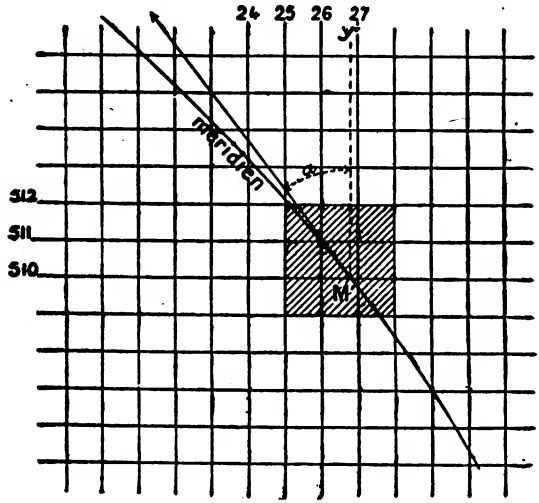
errors which may reach several decigrades, especially in the eastern part of France; it can not be produced into western Germany without introducing angular errors which can not be allowed for very accurate Artillery fire at long ranges.

3. All projections distort lengths. In the Lambert projection the errors do not exceed $\frac{1}{2000}$ of the true length and are practically negligible.

In the Bonne projection the error in Alsace may amount to $\frac{1}{350}$ of the true length, or 30 meters in 10 kilometers.

Geographical north — border — kilometric quadrangles.—To draw up a map, as has been said above, by means of the nu-



merical rectangular coordinates, the points are laid off on a sheet of cross-section paper of the proper scale; the sides of the quadrilateral are parallel to the axes of rectangular coordinates of the projection.

Geographical north.—As we have seen above, the axes of the quadrangles in the Bonne and Lambert projections are not directed toward the north. The meridian of a point M′ is inclined at a certain angle α (between parallel M′Y′ and original meridian OY); this angle is called the angle of convergence of the meridian at the point M′.

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This may be expressed:

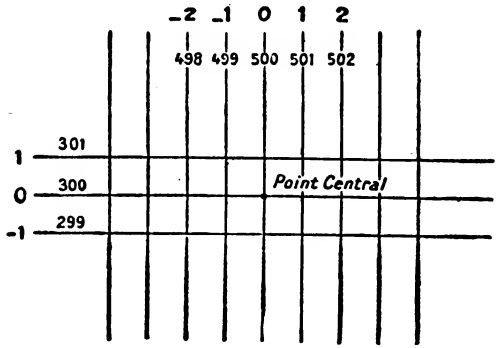
$\alpha = (G - G_o) \sin L_o = (G - G_o) \times 0.76$. (Lambert.)

$\alpha = (G - G_o) \sin L$. (Bonne.)

If an arrow be drawn at M′ inclined at the angle α to the axes of the quadrangle, this arrow will indicate the direction of the meridian; that is to say, this is the geographical north.

The angle of convergence of the meridians varies but little on a large scale map; it is practically the same at all points of the sheet. Therefore, it is sufficient to calculate for the middle of the sheet, and to assume for this calculation an approximate value of the longitude.

Border.—Only a small portion of a large scaled map of a territory can be represented on a single sheet of ordinary paper. The necessary divisions are generally made with a border parallel to the rectangular quadrangles of the projection, and not



parallel to the meridians or parallels. Consequently, the border does not generally give the direction of the north.

Kilometric quadrangles—numbering.—For certain reasons one may be led to remove from the map the original kilometric quadrangle which has served to draw up the map and to apply in its place a new kilometric quadrangle placed in some conventional arbitrary manner. It is well in this case to note exactly the position of the new quadrangle with respect to the original quadrangle; especially the angle of their axes, so as to correct, subsequently, the angle of convergence used to show the arrow of geographical north.

For various reasons, it may be desired to change the numbering of the quadrangle. Thus in the Lambert projection, 500

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kilometers are added to X and 300 kilometers to Y so as to avoid giving negative values to points west and south of the central point. When these changes are made on the map, it is necessarily desirable to modify accordingly the rectangular coordinates of the geodetic points so as to be able to place these points directly on the new quadrangle. These operations are equivalent to changing the origin and direction of the axes of Cartesian coordinates on the map; but they do not imply the slightest change in the method of projection, which remains intact.

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ANNEX II.

CONVENTIONAL SIGNS.

1. CONVENTIONAL SIGNS IN PUBLISHED BATTLE MAPS
2. SUPPLEMENTARY CONVENTIONAL SIGNS TO BE USED IN ALL THE INSCRIPTIONS PLACED BY HAND ON THE BATTLE MAPS OR VARIOUS MAPS USED IN THE STAFFS.

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CONVENTIONAL SIGNS ON DIRECTING PLANS.

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CONVENTIONAL SIGNS ON DIRECTING PLANS—Continued.

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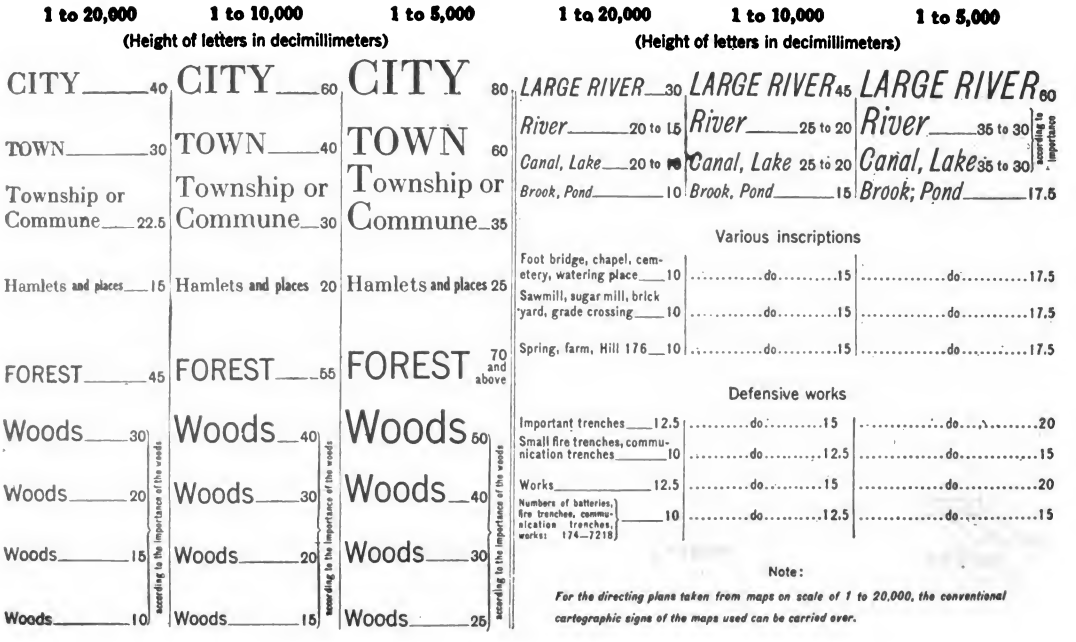
CONVENTIONAL SIGNS ON DIRECTING PLANS—Continued.



Note:

For the directing plans taken from maps on scale of 1 to 20,000, the conventional cartographic signs of the maps used can be carried over.

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DEFENSIVE WORKS

		1 to 20,000	1 to 10,000	1 to 5,000
German works (in blue)	German trenches: by photographic reduction or exact tracings			Firing trenches with loopholes / without loopholes
	Prepared: with loopholes	Passage points	Passage points	
	Prepared: without loopholes	Sometimes on 1 to 20,000		
	Communication trenches: principal			
	Communication trenches: secondary			
	from reports			
	abandoned			1 to 4 pieces
	German batteries: by photographic reduction or exact tracings	4 guns	Isolated strong point (Emplacements 10 on the 1 to 5,000 if there is room) 8 guns	Isolated strong point / to walk
	German batteries: from reports	4 guns	7 guns	
	When the battery is casemated or camouflaged, add abbreviation: Bat. Casem. or Bat. Cam.		If possible the exact number of pieces	
	Anti-aircraft gun			
	Camps, munition depots, wagon parks			
	Works			
	Wire entanglements (Occasionally on the 1 to 20,000)			

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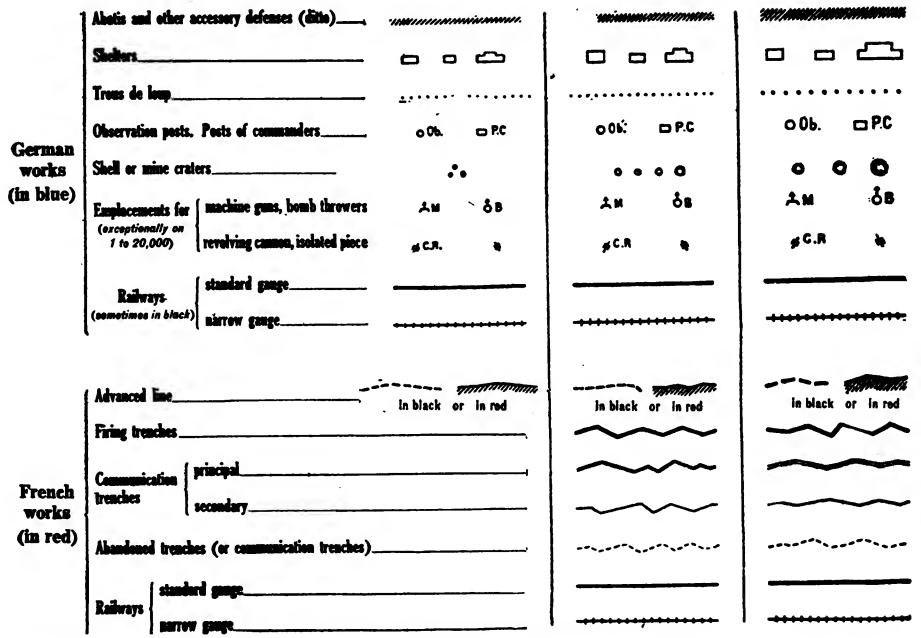
CONVENTIONAL SIGNS ON DIRECTING PLANS—Continued.



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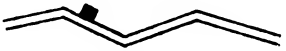
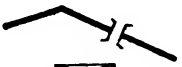
2. COMPLEMENTARY CONVENTIONAL SIGNS TO BE USED IN ALL INSCRIPTIONS PLACED BY HAND ON THE DIRECTING PLANS OR VARIOUS MAPS USED IN THE STAFFS.[1]

1. VARIOUS WORKS AND PARTS OF A PREPARED TERRAIN.

Wire entanglements XXXXXXXX

Turnout in a communication trench . . . . . 

Steps to get in or out of a communication or fire trench . . . . .

Crossing in communication or fire trench . . . . . 

Shelter . . . . .

Post of Commander
- of Battalion . . . . .
- of Regiment . . . . .
- of Brigade . . . . .
- of Division . . . . .
- of Army Corps . . . . .

Infantry observing post . . . . .

Artillery observing post . . . . .
- Occupied . . .
- Prepared . . .

Machine gun shelter . . . . . .
- Occupied . . .
- Prepared . . .

Emplacement for trench mortars
- Occupied . . .
- Prepared . . .

Munition depots . . . . . .
- Cartridge . . .

- Grenades . . .

- Trench engines

[1] The present table annuls and replaces the similar table in the General Staff Officer's Aide-Mémoire.

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Depot of tools and materials .....

Subsistence depot.....

Water supplies .....

Dressing stations .....

II. HEADQUARTERS AND STAFFS.

Commanding general (General Headquarters) .....

Headquarters of group of armies .....

Headquarters 2d Army .....

Director of Supply Service, 2d Army.....

Headquarters 7th Army Corps .....

Headquarters 3d Division (1st of the Army Corps) .....

Headquarters 4th Division (2d of the Army Corps).....

Headquarters 53d Division (3d of the Army Corps).....

Headquarters 65th Separate Division .....

Headquarters 4th Cavalry Division .....

Staff, 25th Infantry Brigade.....

Staff, 3d Cavalry Brigade .....

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III. INFANTRY.

Company of Infantry .....

Company of Chasseurs .....

Group of Cyclists .....

Battalion of Infantry .....

Battalion of Chasseurs .....

IV. CAVALRY.

Squadron of Cavalry .....

Regiment of Cavalry .....

Small group .....

V. ARTILLERY.

Group in park .....

EMPLACEMENT	OCCUPIED	PREPARED
of Field Battery		
of Battery 95		
of Battery 100		
of Battery 105		
of Battery 120 L. (long)		
of Battery 155 L. (long)		
of Battery 120 C. (short)		

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EMPLACEMENT—	OCCUPIED	PREPARED
of battery 155 C. (short)		
of Battery 220		
of Battery 270		
of Battery 370		
Special types (with indication of caliber in centimeters)		
Antiaircraft station		
Infantry munition section		
Artillery munition section		
Section of park		
Artillery park, army corps (1st échelon)		
Artillery park, army corps (2d échelon)		
Échelon of main artillery park		
Échelon along the road		
When movable		
Intermediate depot (Heavy Artillery)		
Park (Heavy Artillery)		

VI. ENGINEERS.

Company of Engineers	
Searchlight section	

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Telegraph detachment of army corps .....

Telegraph section (Army) .....

Telegraph section of 2d line .....

Field radio station .....

Bridge equipage .....

Army corps engineer park .....

Army engineer park .....

VII. AVIATION.

Squadron .....

Aviation park .....

Bombing group .....

Park of bombing group .....

Landing field .....

Captive balloon .....

VIII. AUTOMOBILE SERVICE.

Section supplying fresh meat .....

Sanitary section automobile .....

Section for transportation of matériel .....

Section for transportation of personnel .....

Section of automobile park .....

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IX. SERVICE OF ADMINISTRATION AND SUPPLY.

Section of subsistence supply train .....

Section of auxiliary subsistence supply train .....

Cattle park .....

Army field bakery .....

X. MEDICAL SERVICE.

Ambulance .....

Hospital section .....

Group of stretcher bearers .....

Evacuation hospital .....

Section of evacuation hospital .....

Reserve personnel .....

Reserve matériel .....

Hospital in railroad station .....

Sanitary train .....

XI. MISCELLANEOUS.

Regimental train .....

Field remount depot .....

Headquarters of advanced base beyond rail-head .....

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ANNEX III.

WORKS OF THE TOPOGRAPHICAL SECTIONS OF THE ARMY CORPS.

1. TOPOGRAPHICAL WORK.
2. PHOTOGRAPHIC REDUCTION.
3. STUDY OF AERIAL PHOTOGRAPHS.
4. CARTOGRAPHIC WORK.
5. MATERIALS SUPPLIED TO THE TOPOGRAPHICAL SECTION OF THE ARMY CORPS.

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ANNEX III.

Work of the Topographical Sections of the Army Corps.

1. TOPOGRAPHICAL WORK.

The topographical duties of the topographical sections of the Army corps comprise plane-table map work behind the first lines (location of works, railways, and various points, etc.), particularly in concealed works, for which aerial photography can not well be employed, the location of the first-line trenches with the aid of instruments, and other special operations.

The plane-table maps will be made according to the ordinary methods, with the aid of the network of points furnished by the department of military surveyors.

As far as the mapping of the first-line trenches is concerned, the following instructions will act as a guide:

Topographical determinations may have to be made in the first line, either by locating and marking on the map certain points of our trenches (whose trace can be obtained in fragments with the aid of photographic reductions), or by locating various elements of the enemy first-line trench.

Work in the open up to the first-line trenches being very rarely possible, it is necessary to use instruments and methods which permit operation in the trench itself.

The periscopic alidade, luminous compass, Peigné compass, glasses with micrometer scale, photographic apparatus adapted to use with a periscope, and, in a general way, all angular measuring instruments with periscopic sighting or susceptible of being mounted on a periscope, meet these conditions.

DESCRIPTION OF INSTRUMENTS.

Luminous compass.—The luminous compass is composed of—

1. A base which supports a graduated dial over which moves a magnetized needle.

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2. A movable collar which bears an index and an alidade window. This index permits reading of the angles between the magnetic north and the line sighted through the alidade. This dial can be illuminated for night work.

Use.—Place the blue point of the needle on the zero of the graduation. Turn the alidade disk until the wire in the window is in coincidence with the point sighted. Read the angle on the graduation at the index.

Periscopic alidade.—The periscopic alidade consists of—

A periscopic tube with slides to protect the mirrors. The periscopic tube is mounted on an axis which permits an inclination of the mirrors to the front or rear.

A plate supports the periscope; at the two extremities of this plate are bevels graduated in millimeters, centimeters, and half centimeters.

Each mirror bears a crosscut at its center in the silver backing of the glass; the coincidence of these two axes determines the accurate sighting of the instrument.

Use.—Except for the measurement of slopes, it is used as a plane table alidade (set up the plane table on a given point, mark a direction, take a bearing, an intersection, etc.).

The line of sight is the axis of the mirrors. It is essential that the trace of the two branches of the crosses which are not horizontal be truly vertical.

Angle measuring periscopes (goniometers).—The angle measuring periscope is an instrument intended for the rapid measurement of angles, either in the open or in the trench.

The instrument is fixed on a photographic tripod; a ball and socket joint and a spherical level allow the instrument to be brought to a level.

The lower part of the instrument carries a division whose marks are 20 millimeters apart. An index engraved on the upper portion of the instrument moves with respect to this scale.

In sighting, there is used:

In open ground, the sights on the upper part of the instrument; in the trench, a periscope which is mounted on the upper part of the instrument. On each of the mirrors of this periscope there are engraved rectangles which determine a line of sight.[1]

[1] The periscopes used for the periscopic alidade and the angle measuring periscope are interchangeable.

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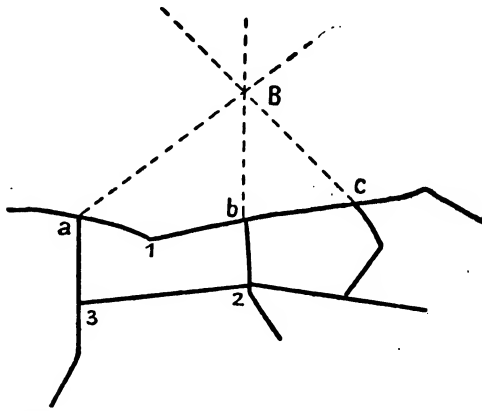
Field glasses with micrometer scale.—The graduation on this glass can be used as a stadia in measuring distances of objects whose dimensions are known (gun shields, sand bags, etc.).

Peigné compass. The instructions glued on the case of this compass indicate the operation and use.

Photographic apparatus (Bloc-Notes Gaumont 4½ by 6).—Mounted on a periscope, it permits the measurement of angular distances and the location on the map of objects photographed from several stations already located on the map.

METHODS TO BE USED IN MAKING MAPS.

Absolute rules can not be given for the work in the first lines, because of the variety of circumstances which may be found. A single method can not be indicated, but a series of means to be



used according to the case. The examples given below show how the common methods of road sketching and of mapping by intersection may be employed.

A.—Assume That it is Desired to Show on the Map, to a Scale of 1 to 5,000, Emplacement B of an Enemy Machine Gun.

1. It is necessary, first, to reconnoiter the position from three points, *a*, *b*, *c*, of our first-line trench, from which can be seen the point B by periscope; then to determine the position of these points.

Make a preliminary reconnaissance with the periscope to find these points and mark them in the trench.

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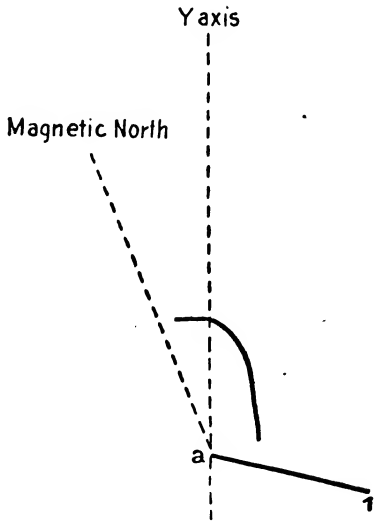
Assume that the point *a* has been identified satisfactorily on the map and on the ground.[1] The positions of the points *b* and *c* are also located on the map by reference to the point *a*.

To do this, take station at *a* with the Peigné compass or the luminous compass. Measure the magnetic azimuth *a*1, then pass to point 1 and take azimuth 1*b*; the distances *a*1 and 1*b* are measured in strides or decameters. To check the accuracy of this operation, continue the road sketch through 2 and 3, then return to the point *a*.



Then proceed to the graphical construction of the road sketch. To do this trace on the battle map or a large scale sketch (1 to

[1] If this point is to be determined, recourse may be had to the following method: Taking position at *a*, measure the angles of direction to several points whose positions are known exactly, triangulation stations, objects previously mapped, or poles held up above points of the trenches or approaches in rear which have already been drawn in accurately; the angles measured (in three directions at least, corresponding to points not on the circumference of the same circle with the point from which they are measured) are laid off about a single point on a sheet of paper. When this sheet is properly placed on the field sheet it gives the location of the point whose position was to be determined. The point *a* can also be intersected from the rear by the method indicated below in the location of the point B, etc.

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5,000) a line parallel to the axis of Y and passing through *a*. Trace by reference to this line the line of magnetic north. The measured angle should be laid off from this direction. The distance *a*1 is laid off to scale.

The road sketch *a*1, *b*2, 3*a* being constructed graphically, distribute the error of closure.[1] The point *b* is determined on the plan. In the same way determine the point *c*.

2. Knowing the position of *a*, *b*, and *c* on the map, it only remains to determine the point B by taking station at the points *a*, *b*, and *c* marked in the trench.

These determinations are made, for example, by means of a plane table and periscopic alidade. The points *a*, *b*, and *c* being located on the plane table, take station at *a*, orient the plane table by the orienting compass or, better, by sighting on a mark far enough away, mark with the periscopic alidade the direction *a*B. Set up at *b* and mark *b*B, then set up at *c* and mark *c*B, seeing that good intersections are obtained. Locate on the battle map the point B thus obtained.

By working on a map to the scale of 1 to 5,000 placed on the plane table, the position of the point B may be obtained directly.

OTHER METHODS.

1. The use of the above process assumes that the compass may be used at the different stations of the road sketch, *a*1, *b*2, 3*a*. The proximity of wire entanglements (10 meters away, for example) or of gun shields (a few meters) can prevent the use of this method. In this case it is necessary to make the road sketch by using an angle measuring instrument, taking at each apex the angle of the two adjacent sides, and in addition the angle from one of the sides (side of departure *a*1 or of closure *a*3) with the direction of a distant mark whose position is known; the construction is made by the observer, preferably to a large scale for greater accuracy.

The graphical determination of the point B may follow the same process as the measurement of the angles *a*, *b*, *c*, by means of a periscopic goniometer of any nature.

[1] It is well to verify that the whole of the figure, *a*1, 2*b*, 3*a*, is correctly oriented, taking the direction of a known point from one of the apexes of the figure; it is shown graphically by reference to the adjacent sides by the aid of the periscopic alidade, or, just as well, by measuring the angle by means of the angle-measuring periscope.

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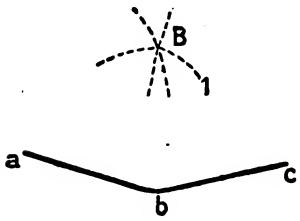
2. Another method of locating the point B is to measure the distances *a*B, *b*B, *c*B.

At the points *a*, *b*, *c*, previously located, measure with the micrometer telescope, referring to objects of known average dimensions (sandbags, intervals between two loopholes, etc.), the distances *a*B, *b*B, *c*B.



For example:

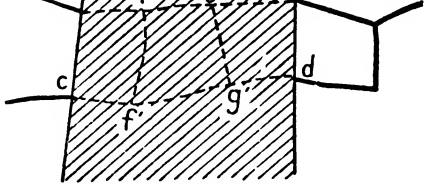
75 meters_____*a*B
80 meters_____*b*B
100 meters_____*c*B

Open a compass to scale 75 meters, describe the arc I. The point B is on this arc. Perform the same operations from *b* and *c* with the compasses open to the proper scaled distances. The point B is at the intersection of these arcs.[1]

B.—Locating Elements of Our First Line Not Shown on Photographs.

A tree has hidden from the camera the part of our trenches between *a* and *b*.

The points *a*, *b*, *c*, and *d* of the map are easily identified on the ground, since they are at the edge of the wood.



By a road sketch with the Peigné or luminous compass, connect *a* and *b*. Connect likewise *c* and *d*; the details of the area between *ab* and *cd* is obtained by secondary traverses, such as *ff'*, *gg'*, etc.

[1] The above operations are not applied to the actual point B, but to a distinct object located close to it (preferably elevated, a tree, for example), and whose position with reference to the point B may be known (by aerial photographs or otherwise).

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C.—Use of Panoramic Photographs.

A photograph taken from a point of a trench may allow the determination of the angular distances while avoiding the work in the open.

Besides, if a second photograph is taken under the same conditions, from another point, the positions of a certain number of points common to the two photographs may be determined by intersection.

For the graphical construction of this intersection it is necessary to mark on the photographs the azimuths at the point of operation at which the pictures were taken.

2. PHOTOGRAPHIC REDUCTIONS.

Photographic reductions, made by the topographical section of the Army corps, are primarily for the purpose of giving the battle maps the details of the defensive works of the enemy. When necessary, they serve to correct and bring up to date the planimetry of these maps.

Among the methods of reduction which are employed, there may be cited:

1. *Method of anharmonic pencils* (*from notes*).—This purely geometrical method permits a rigorous construction, point by point, of all the details of the photograph, when the four points A, B, C, D, whose exact position is given on the battle map (A′ B′ C′ D′), are known.

Assume that it is required to locate the fifth point E; join all these points to one of them, A; we thus form a pencil of four right lines. Because of the law "the anharmonic relation of a pencil of four lines is retained in projection," we can make the entire secant (*b c e d*) pass rigorously from the first pencil onto the second, where it falls in the position *b′ c′ e′ d′*, while preserving the relative lengths; by means of this transposition, the direction of the point E′ is obtained and consequently the line A′ E′, homologous to AE.

In the same manner the right line B′E′ should be obtained, then the position of the point E′ is given by the intersection.

This laborious process offers practically but little interest.

2. *Camera lucida.*—This arrangement permits the projection of the photograph directly onto the battle map; the two images are made to coincide by varying the distance, inclination, and orientation between the photograph and the map.

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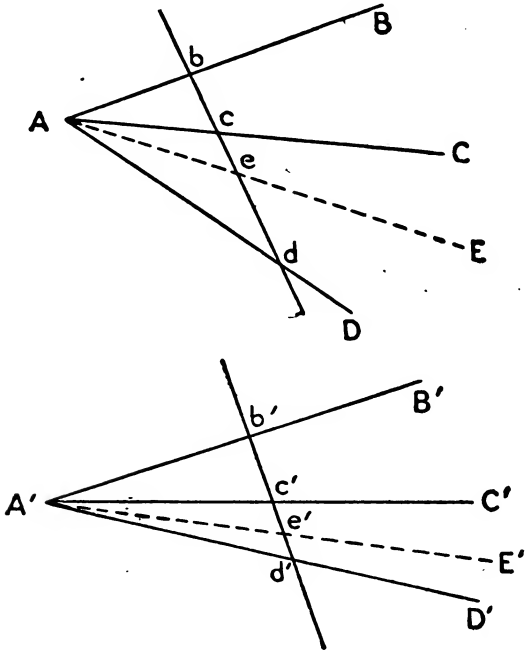
It is then sufficient to trace with a pencil on the battle map all the details to be reduced.

3. *Photographic retouching apparatus.*—By means of this apparatus, with the aid of a source of light, the negative of the photograph is projected on a screen whose inclination and distance from the source may be varied. The battle map is placed on the screen (or a copy on which have been drawn to the desired scale the main lines of the triangulation of the map);



coincidence is obtained by moving it about on the screen. Having obtained this coincidence, the battle map is replaced by a sheet of sensitized paper, and a photograph is obtained which is an image of the terrain to required scale.

By drawing in the different details on this photograph, with indelible ink or various colored crayons, then washing in permanganate acid (1 liter of water, 2 grams permanganate, 10 grams sulphuric acid), plunging in water, then in hyposulphite, a true section of the map to the desired scale is obtained.

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4. *Rapid method.*—This consists in making a rapid reduction according to the following principles:

1. The points in a right line on the photograph are preserved in a right line on the ground (alignments).

2. On any given right line the relations of the distances are sensibly the same on a photograph as on the map when a limited area only is considered.

First, a certain number of the right lines and points of the photograph are traced and reduced in accordance with these principles, and then the network thus formed is completed by eye.

Finally, it is necessary to mention as a very rapid method a much-used method, whose very simple process consists in locating the elements by eye when they can be inserted in the portions already reduced and located on the maps and sketches, or in the limits of cultivated ground located by the aid of Cadastral maps.

Observation of primary importance.—All these methods assume essentially that the ground photographed is plane. It is always better to have the photographs sensibly vertical.

3. STUDY OF AERIAL PHOTOGRAPHS.

The collection of photographs given here show how the various elements of the enemy organization are generally indicated.

Approved examples have been taken for their clearness and similarity to those which have to be handled most frequently. To examine the photographs it is necessary to use magnifying glasses and at times stereoscopes. Certain elementary observations facilitate this investigation.

Example: Occupied batteries are indicated by paths; the small paths in the immediate vicinity of the batteries lead to the shelters for the personnel and to the magazines. The effect of the blast from projectiles may sometimes be seen on the ground in front of the mouths of the pieces.

Machine guns can be placed only at points in the ground where they can have a sufficient field of fire and a real value for the defense. They are often under shelter and generally very difficult to discover.

At the ends of the advanced approaches are found listening posts or observing stations.

Certain camouflage installations may be revealed by their shadow.

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All the dummy emplacements (batteries, machine guns, etc.) are built in such a way as to show up particularly well on the photographs. Consequently, some very obvious images are suspected.

4. CARTOGRAPHIC WORKS.

1. PREPARATION OF CARTOGRAPHIC BASE FOR PLANS AND NEW SKETCHES.

The cartographic works prepared by the topographical section of the Army corps consist principally in the establishment of notes for maps or sketches to a large scale, with a view to their publication by the aid of the rapid method of reproduction which are at the disposition of the section (multicopy, cyclostyle, small printing press, heliotype, and photography).

It is well to perform this work in a uniform manner and especially to do it, no matter what the scale may be, on cross section paper, printed for battle maps of the military surveyors of the Army. When this is not available, use that of the French official map on cross section paper to a scale of 1 to 50,000, so as to assure the unity of the whole and to facilitate a comparison of all the documents distributed in the Army.

It may suffice very often to publish prints obtained by enlargement, pure and simple, of the battle map or the French official map, already on proper cross section paper and retouched at certain points. But it is necessary to remark that, for various reasons (shrinkage of paper, errors in the drafting of the map), the enlarged print does not always retain its initial value, even if the original map is accurate.

The geodetic point especially, the test of every good map, will rarely fall in its place when it is checked by means of coordinates; it is necessary, if accuracy is going to be necessary, to redraw the map.

Eventually it will be found necessary to dispose of a series of maps of different scales and to adjust the whole by a common triangulation network.

The common and correct method, to be adopted in drawing up the map, is the following:

A.—Determination of the Division Into Sheets of the Map to be Published.

The limits of the area considered are traced on the battle map or on the French official map on cross section paper to the scale

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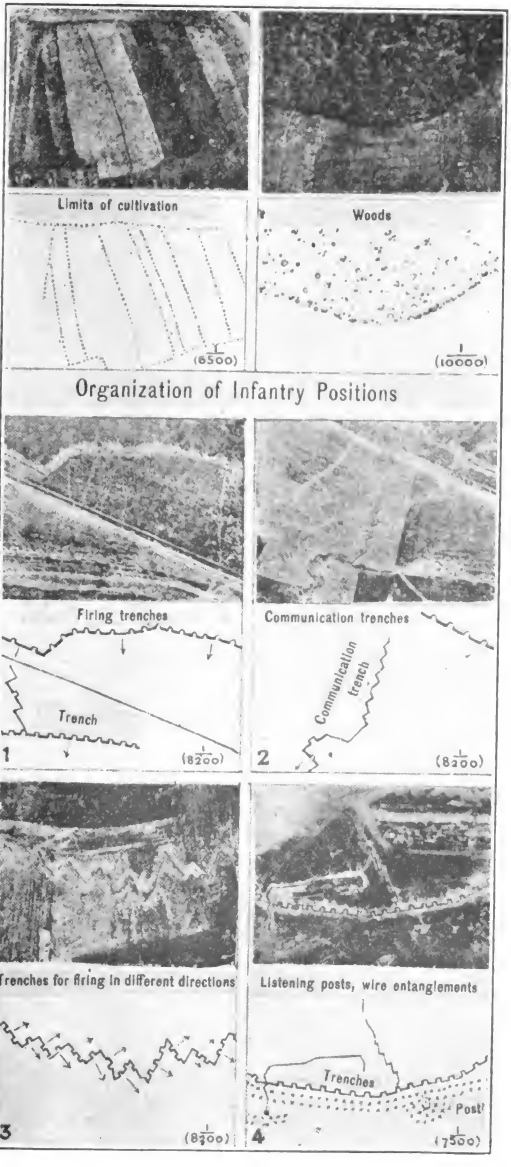

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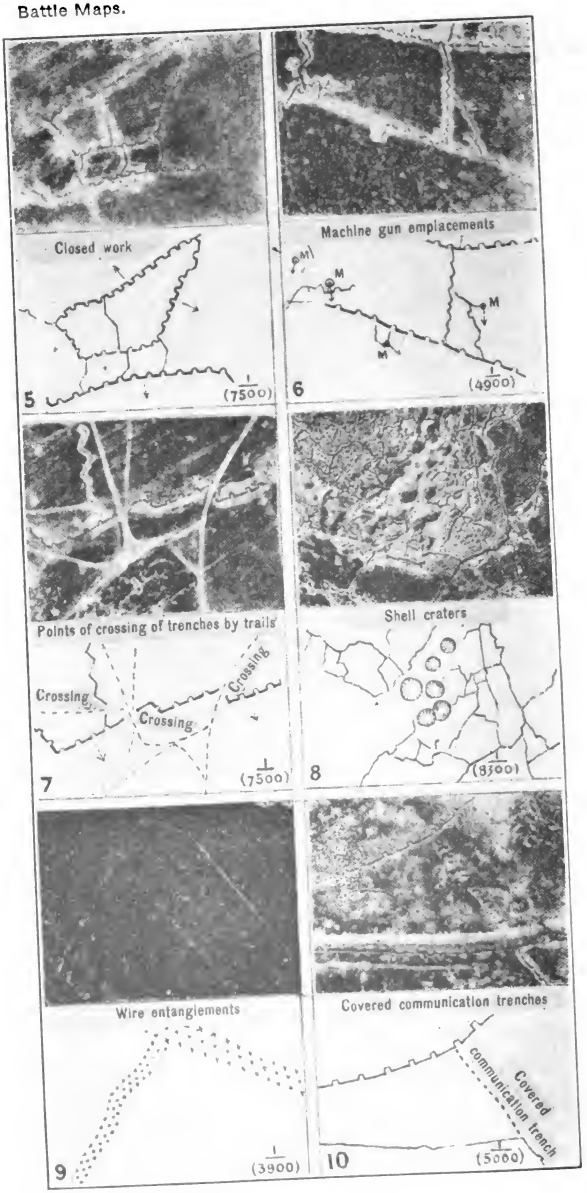

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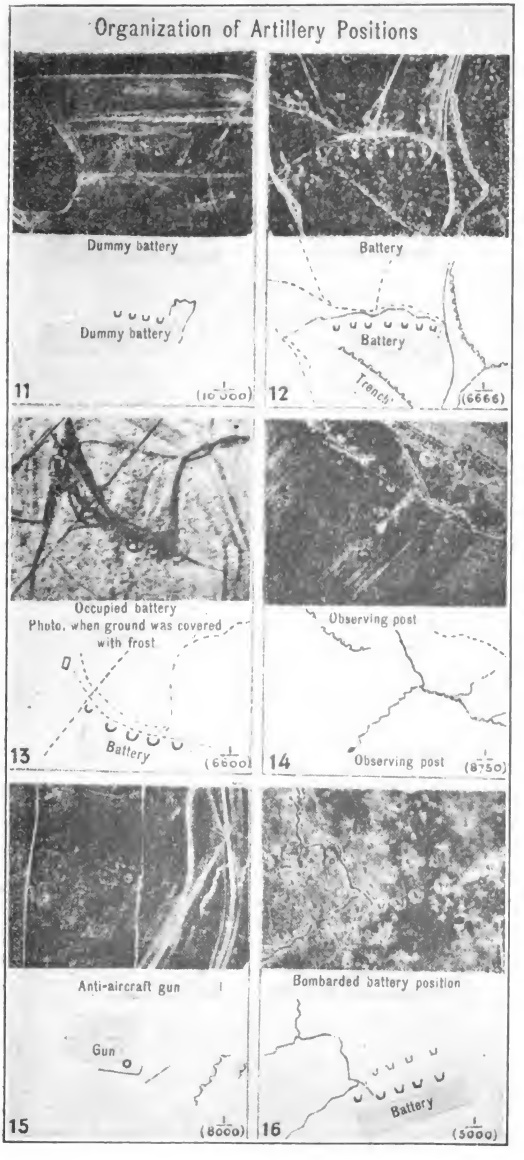

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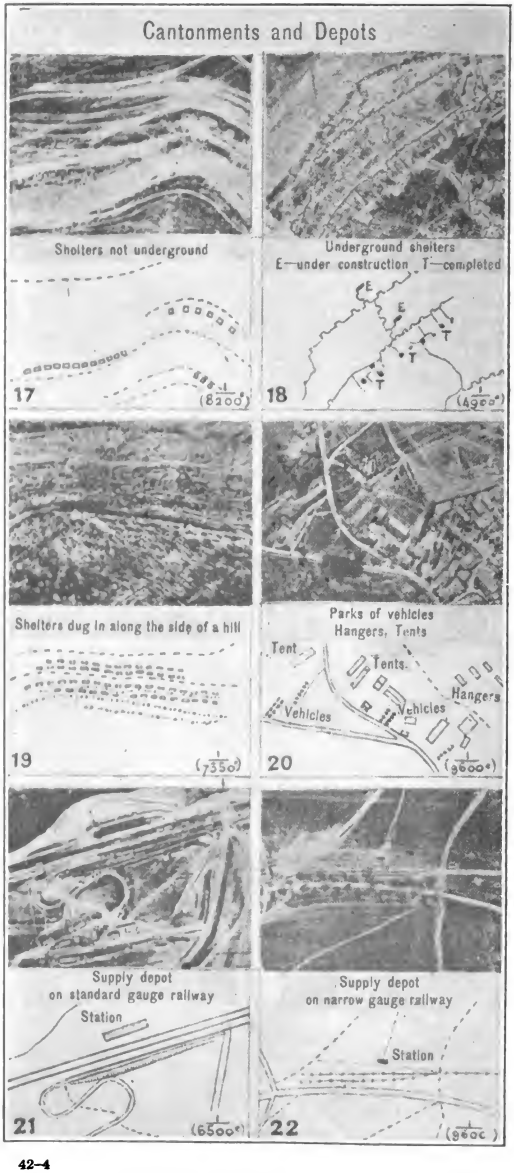

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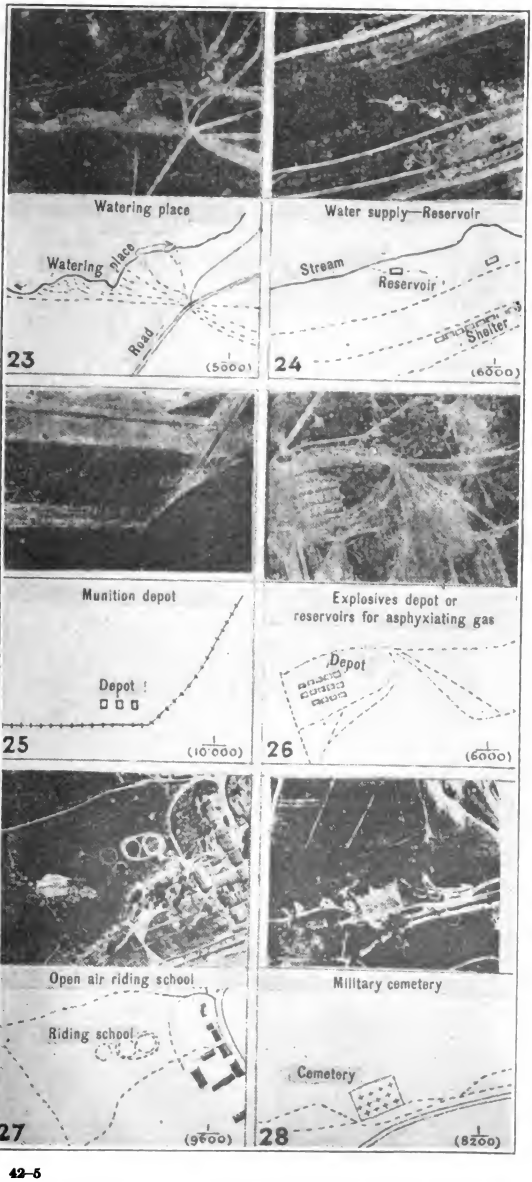

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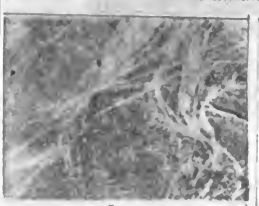
Communications



Trails

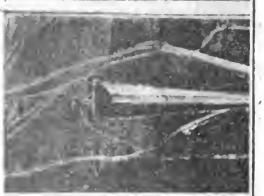
29 (1/10,000)

Trails in use
Abandoned trails

30 (1/5370)

Trails for convoys

31 (1/7500)



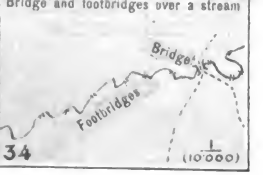
Standard gauge railway tunnel

32 (1/10,000)

Military railway

33 (1/9600)

Bridge and footbridges over a stream



34 (1/10,000)

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of 1 to 50,000 and divisions are adopted which are appropriate to the dimensions of the sheets that are going to be published.

B.—Enlargement.

Enlargement to the desired scale of the battle map or of the French official map on cross section paper.

If this enlargement has not been completed already, it is done by one of the following methods:

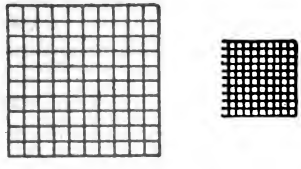
1. Method of small squares.

Use two grids traced on tracing paper and representing a square kilometer to the scale of the two maps (battle map; map to be made).

2. Camera lucida.

3. Photography.

Note.—If neither the battle map nor the French official map on cross section paper is at hand, it will be well to ask the de-



partment of military surveyors for a copy of the proper grid and to trace it on the French official map.

For this purpose:

Construct a kilometric grid on tracing paper;

Place the geodetic points by their coordinates on the grid;

Check, by superimposing, the coincidence of these points on the tracing paper and on the map;

Prick through the axes of the squares;

Rule the sheet into quadrangles and number these quadrangles.

C.—Working up Field Notes.

1. *Lay the sheet off as cross section paper.*—The dimensions to be given to the squares are those of the kilometric quadrangles corresponding to the scale of the map to be published, knowing that—

Squares of 10 centimeters correspond to a scale of 1 to 10,000.

Squares of 20 centimeters correspond to a scale of 1 to 5,000.

If necessary, trace intermediate lines showing the hectometric ordinates and abscissæ.

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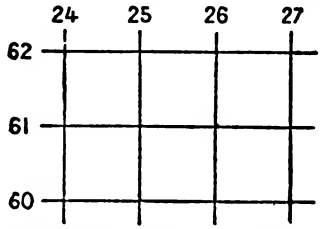
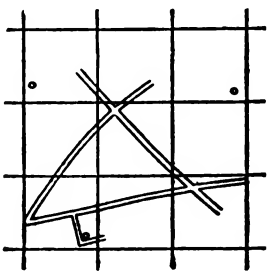
2. *Numbering of quadrangles.*—Write on the sides of the quadrangles the kilometric number which corresponds to the square on the adopted sheets. Note that the numbers increase toward the north and east.

3. *Place on this quadrangle the existing geodetic points.*—To do this use their numerical coordinates furnished to the nearest meter by the department of military surveyors of the Army.



4. *Locate the planimetric outline—Roads, principal details.*—Printed in the enlargement of the battle map or of the French official map.

Work from square to square, moving the paper which shows the enlargement, considering the field notes, the position of the planimetry with reference to the geodetic points, and, if necessary, making adjustments and the necessary corrections by eye.



5. *Interpolate the new original maps in the network (maps of detail, etc.).*—These maps are first reduced or enlarged to the desired scale by the methods above indicated.

They serve to complete the above planimetric outline and when necessary to correct it in places where it is known to be defective.

It is well in this operation to proceed carefully and to give maps used an order of preference according to their reliability.

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The map resulting from the reduction of a map executed on a large scale ought always to be preferred to the map resulting from an enlargement.

2. CORRECTIONS—FORM TO BE GIVEN THEM.

The corrections published by the topographical section of the Army corps are for the purpose of giving to the owners of maps in use in the Army corps the additions and modifications which should be added to them to keep them up to date with the latest photographs or the latest data received.

They should be prepared, drawn, and distributed with all the care possible, particularly in periods of active operations.

Each correction bears a title mentioning the battle map to which it pertains (its scale, date of its edition, its serial number—in a particular series for each map and started over again with each edition—and finally a date—that of the last data recorded). The numbering of the squares should be self-evident. A legend and all the explanations necessary for an exact interpretation of the map are also added.

The printing may be done on a hectograph (à la pâte) if it is a question of corrections of small size, in order that they may be gotten out as often as possible. If this very rapid process can not be used, recourse may be had to printing by means of cyclostyle or the lithographic press.

5. MATERIAL SUPPLIED TO THE TOPOGRAPHICAL SECTION OF THE ARMY CORPS.

DRAWING MATERIAL.

One cyclostyle with accessories and various supplies, double foolscap size.

One zincographic press with accessories and supplies, double foolscap size.

One printing frame, size "demigrand aigle," with developing tank, double foolscap size.

Two drawing boards (0.75 meter by 1.05 meters).

Three flat drawing rules and squares.

Four trestles with adjustable legs.

One case containing compass with interchangeable points, extension leg, and proportional compass.

One scale of 75 centimeters length.

Three 20-centimeter boxwood scales.

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One eraser.
Six cups.
One tin map tube.
One sketching board, size 0.80 meter by 1.10 meters.
One camera lucida with arrangement for reduction and erection of image.
One large hand magnifying glass.
One heavy magnifying glass on tripod.
One hand stereoscope.

TOPOGRAPHICAL MATERIAL.

Two plane tables, 0.40 by 0.50 meter, with support, covering, and orienting compass.
Ten plane tables, 0.33 by 0.33 meter, with support, covering, and orienting compass.
Twelve leveling alidades.
One semicircular protractor in mils.
One semicircular protractor in grades.
One semicircular protractor in degrees.
Two Peigné compasses in mils.
Two luminous compassés in mils.
One periscopic photographic apparatus (Commandant Malle) with enlarging cone and accessories for development.
Three periscopic alidades without telescope.
Two periscopic goniometers (angle-measuring instruments).
One 10-meter tape.
One graduated zinc square.

OFFICE SUPPLIES.

Various. In addition, the topographical section of the Army corps will be provided with the necessary material for the Infantry observing posts provided in the instructions of December 4, 1915, covering this subject.
The principal material required for the observatory is:
One prism binoculars, 6 to 8 power.
One watch.

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ANNEX IV.

CHARTS OF MAGNETIC DECLINATION.

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ANNEX IV.

CHARTS OF MAGNETIC DECLINATION.

INSTRUCTIONS FOR THE USE OF MAGNETIC DECLINATION CHARTS.

The magnetic declination charts of northeastern France and western Germany have been drawn up according to observations which had been taken for a sufficient length of time, prior to January 1, 1916, for comparison with the corresponding observations of Parc-Saint-Maur and of Val-Joyeux. Under these conditions, the lines of equal declination which are traced there can only be considered as having an error which is not greater than 20′.

In using these maps, first locate your position thereon. A simple interpolation between two lines of equal declination, which contain the point between them, gives the declination for the 1st of January, 1916. This first result is then corrected for secular and diurnal variation.

The secular variation is nearly constant, for the regions represented on the two maps, about —16′ per year. The correction resulting from this variation is proportional to the time elapsed since the first of January, 1916.

To allow for the diurnal variation, there is then applied to the result a correction taken from the following table for the month and hour of observation. This correction is zero a little after 10 hours and near 18 hours.

[Hours (o'clock counted from midnight to midnight).]

Month.	6 h.	8 h.	10 h.	12 h.	14 h.	16 h.	18 h.
January	0′	−2′	0′	+ ′	+ 6′	+2′	0′
February	−2′	−4′	−2′	+6′	+ 7′	+4′	0′
March	−2′	−6′	−4′	+7′	+11′	+6′	0′
April	−4′	−9′	−4′	+9′	+13′	+6′	0′
May	−7′	−9′	−2′	+9′	+13′	+6′	0′
June	−9′	−9′	−2′	+9′	+13′	+7′	+2′
July	−7′	−7′	−2′	+9′	+11′	+6′	+2′
August	−6′	−7′	0′	+9′	+11′	+4′	0′
September	−4′	−6′	0′	+9′	+ 9′	+4′	0′
October	−2′	−6′	−4′	+7′	+ 9′	+4′	0′
November	0′	−2′	−2′	+6′	+ 7′	+4′	0′
December	0′	−2′	0′	+4′	+ 6′	+2′	0′

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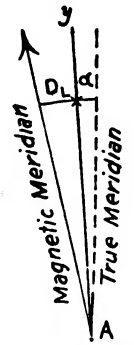
Example.—Required the magnetic declination of February 20, 1916, at 14 hours (2 p. m) at a place located approximately in latitude 54° 39′ G., longitude 2° 97′ G., east of Paris.

The magnetic declination map of northeast France gives for this point	13° 42′ G.
Secular variation for 0.14 year, —16′ by 0.14=	—2′
Diurnal variation (tables)	+8′
Declination to the west	13° 48′ G.

The magnetic declination is referred to the geographical meridian at this place. If it is desired to obtain the angle D_L, which is the angle between the magnetic needle and the parallel to the axis of Y in the Lambert system passing through the point A considered, it is necessary to add or subtract a corrective value a, which depends on the longitude and which is zero



(longitude de A < 6G.)

for points along the meridian of 6° G. on which is found the origin of coordinates for the Lambert system. The absolute value of a is obtained by interpolation in the tables given below; it is to be added to the declination if the longitude of A is greater than 6° G., and to be subtracted from this declination when the longitude is less than 6° G.

Longitudes.[1]	0G / 12G	1G / 11G	2G / 10G	3G / 9G	4G / 8G	5G / 7G	6G
a	4G,56	3G,80′	3G,04′	2G,28′	1G,52′	0G,76	0

[1] 1G = Grade = $\frac{9}{10}$ degrees or $\frac{1}{100}$ of 4 right angles.

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Thus in the preceding example, it is found in the table that for the longitude 2° 97′ G., a=2° 30′ G., and the correction is subtractive. We, therefore, have:

$$D_L = 13° 48' \text{ G.} - 2° 30' \text{ G.} = 11° 18' \text{ G.}$$

Important remarks.—In addition to the errors of the magnetic charts which are allowed for in the declination calculated as indicated above, numerous other causes of error may increase the difference between the true direction of the magnetic needle and the calculated direction; such are the various local magnetisms produced by certain terrain, magnetic disturbances, etc. Aside from these causes from which the operator of the compass can not free himself there are still others whose influence is easy to avoid, such as the proximity to masses of iron or steel (pieces of artillery, projectiles, etc.) and telephone and electric lines. It suffices for this to place himself 40 meters, at least, away from a battery or electrical line.

It should be remembered from the above that a direction given by a magnetic needle will only be approximate.

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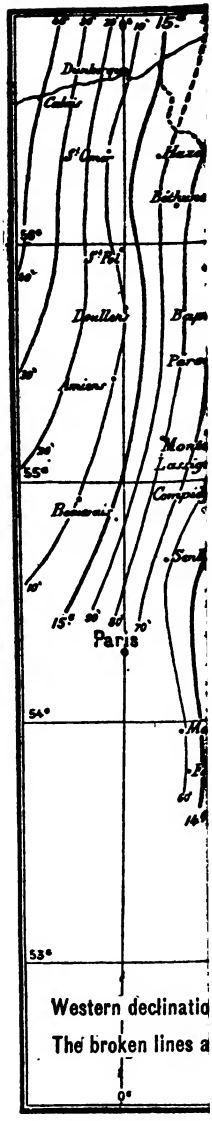

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ANNEX V.

NOTES ON THE FRENCH, BELGIAN, AND GERMAN MAPS OF DIFFERENT SCALES.
4. INDEX MAPS.

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ANNEX V.

Notes on the French, Belgian, and German Maps of Different Scales.

MAPS OF FRANCE.

Maps to the scale 1 to 80,000.—Maps drawn up on a scale of 1 to 40,000. Bonne projection; the center of projection is found at the intersection of the meridian of Paris and the parallel of latitude 50g.

Each sheet is divided into quarters, each having the dimensions of 40 centimeters by 25 centimeters, or of 32 kilometers by 20 kilometers.

At each corner are indicated the longitude with reference to the meridian of Paris, the latitude expressed in grades, seconds, or tenths of seconds, as well as the rectangular coordinates with reference to the center of projection.

The map is printed in black. Slopes are represented by cross hatchings normal to the contours.

Map to the scale of 1 to 50,000, in black.—Exact reproduction of the 1 to 80,000 map, enlarged by photography; also printed in black. This is the map which is laid off in quadrangles of the adopted system of projection (Lambert).

Maps to the scale 1 to 10,000 and 1 to 20,000.—The maps to the scale 1 to 10,000 are obtained from accurate maps drawn up on the ground to the scale of 1 to 10,000. "Polycentrique" projection.

The elevations are adjusted to the general elevations of France.

The contours are at 5 meters interval, with intermediary contours at intervals of 2.5 meters in very flat areas.

Each sheet of the 1 to 10,000 map covers a distance of 5 minutes, centesimal, of latitude and longitude.

The maps, 1 to 20,000, are obtained by photographic reduction from those of 1 to 10,000; each sheet of the 1 to 20,000 contains four sheets of the 1 to 10,000 not joined, but simply placed by the side of one another, with an interval separating them.

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It results from this that the maps can not be used in the ordinary manner in every case, especially in taking angular measurements and distances from them.

The sheets, 1 to 10,000, are printed in black.

Maps 1 to 50,000, in colors.—Prepared by means of maps 1 to 10,000 for the plains and country of average roughness, and from maps 1 to 20,000 in mountainous country.

"Polycentrique" system of projection. Each sheet represents a surface 20 minutes, centesimal, in latitude and 40 in longitude, which corresponds for the northern zone to a dimension of about 40 centimeters by 50 centimeters. (8 sheets for 1 to 20,000, or 32 sheets, 1 to 10,000.)

The topography is shown by contours at intervals of 10 meters touched up with a stump. (Short conical rubber bar by which colored crayons may be distributed or colors toned down.)

Printed in eight colors: Maps in course of preparation; there are only a very limited number of these sheets in existence. (See index map.)

Maps to the scale 1 to 200,000.—Derived from the 1 to 80,000. Each sheet corresponds to 4 sheets of the 1 to 80,000 (128 kilometers by 80 kilometers).

Topography is represented by contours at 40-meter intervals, with intermediary contours at 20-meter intervals for the plain areas, and heavier contours at 200-meter intervals, the whole touched up with a stump.

Printed in six colors: A new type (1912) shows the following improvements:

Localities shown in detail, indication of mills, factories, isolated buildings, chateaux, etc.

Highways and coach roads alone are shown in red, dirt roads and paths are shown in black.

The population of communes is indicated by the number of hundreds of inhabitants.

Bridges and stream crossings are shown by a special conventional sign.

Topography is represented by contours at intervals of 20 meters, with heavy contours at intervals of 200 meters.

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MAPS OF BELGIUM.

Maps to the scale 1 to 20,000.—Drawn up from the cadastral maps reduced to 1 to 20,000, checked up and completed on the ground.

They are based on the Bonne projection, on the meridian of Brussels, and the parallel of 56°.

Topography is shown by contours at intervals of 1 meter on the left bank of the Meuse and at intervals of 5 meters on the right bank.

Printed in black.

Certain important parts have been enlarged to 1 to 10,000.

Maps to the scale 1 to 40,000.—Maps constructed by assembling and reducing sheets of the 1 to 20,000. Each sheet comprises four sheets of the 1 to 20,000 map.

Contours are spaced at intervals of 5 meters.

Printed in black (a new edition is published with streams in blue and highways in red).

Maps to the scale 1 to 100,000.—Reduced from the 1 to 40,000. Each sheet comprises two sheets and two half sheets of the 1 to 40,000.

Contours are spaced at 10-meter intervals.

Printed in six colors.

MAPS OF GERMANY.

Maps to the scale of 1 to 25,000.—These are reproductions of original maps to the scale of 1 to 25,000, prepared with a view to the establishment of the general map to the scale of 1 to 100,000.

Polyhedric projection: Origin of longitudes is the meridian of the island of Fer, 20°, sexagesimal, to the west of that of the observatory of Paris.

Area of each sheet is 6 minutes, sexigesimal, in latitude and 10 minutes in longitude (144 square kilometers, approximately).

Topography is shown by contours at intervals of 10 meters in very broken areas, and of 5 meters in rolling country, with intermediate contours at 2.5 meters, and even 1.25 meters on very gentle slopes. Heavy contours are shown at every 20 meters. The contours are numbered along the borders and at various points along the curves themselves.

They are printed in black, with water in blue. These sheets, usually referred to as "planchettes" (small boards), have been

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published for a large part of Germany. They have been prepared for Alsace-Lorraine and the Rhenish Provinces.[1]

Maps to the scale of 1 to 100,000.—These are prepared by the reduction of the sheets to the scale of 1 to 25,000. Each sheet covers 15 minutes, sexigesimal, in latitude and 30 minutes in longitude.

There are numerous conventional signs and details.

Relief is shown in hachures normal to the contours.

There are two scales along the lower border—one in meters and paces, the other in geographical miles.

They are printed in black.[2]

MAPS WITH SQUARES LAID OFF ON THEM.

The geographical service makes special prints of maps to the scale of 1 to 50,000, with quadrangles laid off in the Lambert system, of the whole of northeastern France, Alsace-Lorraine, and Germany, and prints of maps to the scale 1 to 40.000 of Belgium likewise laid off in quadrangles of the Lambert system.

[1]All the sheets of Alsace-Lorraine have been enlarged by the geographical service to a scale of 1 to 20,000, and printed in black.

[2]A map to the scale of 1 to 50,000, in black, has been prepared by the geographical service by enlarging the 1 to 100,000.

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50,000.

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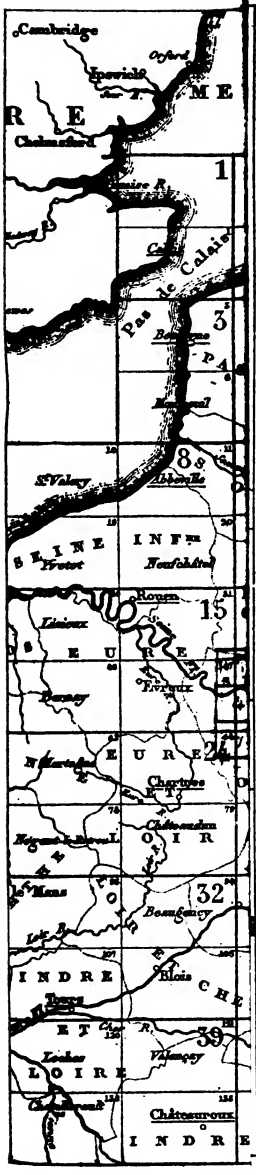

LÉGENDE

1. PONTOISE (XXII-13).
2. L'ISLE-ADAM (XXIII-13).
3. DAMMARTIN (XXIV-13).
4. VERSAILLES (XXII-14).
5. PARIS (XXIII-14).
6. LAGNY (XXIV-14).
7. RAMBOUILLET (XXII-15)
8. CORBEIL (XXIII-15)
9. BRIE-COMTE-ROBERT (XXIV-15).
10. LA FÈRE (XXVI-10).
11. SOISSONS (XXVI-11).
12. LONGUYON (XXXII-11).
13. AUDUN-LE-ROMAN (XXXIII-11).
14. BRIEY (XXXIII-12).
15. CHAMBLEY (XXXIII-13).
16. PONT-A-MOUSSON (XXXIII-14).

(Édition Provis.re)

17. NOMÉNY (XXXIV-14).
18. TOUL (XXXIII-15).
19. NANCY (XXXIV-15).
20. PARROY (XXXV-15).
21. BERTRAMBOIS (XXXVI-15).
22. VEZELISE (XXXIII-16).
23. BAYON (XXXIV-16).
24. LUNÉVILLE (XXXV-16).
25. CIREY-SUR-VEZOUSE (XXXVI-16).
26. CHATENOIS (XXXIII-17).
27. MIRECOURT (XXXIV-17).
28. RAMBERVILLERS (XXXV-17).
29. SAINT-DIÉ (XXXVI-17).
30. ÉPINAL (XXXIV-18).
31. BRUYÈRES (XXXV-18).
32. GÉRARDMER (XXXVI-18).
33. REMIREMONT (XXXV-19).
34. BUSSANG (XXXVI-19).
35. BALLON D'ALSACE (XXXVI-20).
36. BELFORT (XXXVI-21).
37. DELLE (XXXVI-22).

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ANNEX VI.

NATURE OF THE TOPOGRAPHICAL WORK TO BE DONE IN PREPARING BATTLE MAPS OF THE REGIONS NOT ACCURATELY MAPPED.

(Work done by the department of military surveyors or under its direction.)

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ANNEX VI.

Nature of the Topographical Work to be Done in Preparing Battle Maps of the Regions not Accurately Mapped.

The terrain in rear of the first lines forms a zone of maneuver. of temporary occupation, or of retreat, of which all the topographical details should be shown on the battle map.

The location and condition of all roads, the shape of the ground, and planimetric details of works prepared for offense or defense are the indispensable details which permit arriving troops to travel without hesitation, to occupy rapidly sectors which have been assigned to them, and permit supplies to follow fixed routes; and which permit the second lines of defense to be studied or constructed as is convenient, etc.

This zone, which extends 6 or 7 kilometers in rear of the first line, may become, in case of local and momentary recoil, the objective of artillery fire. In this case, important advantages would be derived from its exact representation on the battle map.

The 1 to 80,000 enlarged and the cadastral map can not give all the necessary details, so that it is necessary to remap the terrain. This additional mapping work, undertaken after the arrival at a new position, can not be conducted according to the ordinary methods, since military necessities impose special urgency in the execution of various parts of the map. Consequently, it is necessary to give the useful elements for the preparation, during this interval, of a provisional battle map, to supplement the information from cadastral maps and photographs. Thus a start is made by determining, with the aid of geodetic points of the general triangulation system, some of the critical points of the terrain (crossroads, woods, roads, etc.) which permit the assemblage of the cadastral maps and the photographic reductions.

The establishment of this topographical network will permit a topographer, at the same time to make a reconnaissance of his territory and thus will facilitate his later work.

Then the map proper is begun by connecting important parts; the zone near the batteries is covered first; next the points which

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offer some particular interest are located (works of defense, approaches, roadways, passageways, etc.). The interior of villages may be left until last, or simply printed from photographs or old maps.

Thus the map will be undertaken by sections, most of the time separated. It will finally work out that the parts already mapped will be interconnected.

The scale varies according to the density of details and the accuracy required.

The whole is drawn up to a scale of 1 to 20,000 with contours at intervals of 5 meters. The work may be done at a scale of 1 to 10,000 or 1 to 5,000. It is never completed on the plane table; the drawing is carefully reproduced on a copy designed for the recording of notes for the battle maps.

To obtain a rapid and accurate map, it is necessary that the topographer who does the work be familiar with all the topographical methods; that he rapidly sizes up the general form of the terrain; that he makes reconnaissance of the parts of the ground which offer special military value; that by a well-planned general scheme he locates the details in the order of their importance in the whole; that he be accustomed to work with signals which are distant and scarcely visible.

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